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BULLETIN

OF THE

AMERICAN GEOGRAPHICAL SOCIETY

Vol. XLIII **1911** **No. 10**

GLACIERS OF PRINCE WILLIAM SOUND AND THE SOUTHERN PART OF THE KENAI PENINSULA, ALASKA

IV.—GLACIERS OF THE SOUTHERN COAST OF THE KENAI PENINSULA*

BY

U. S. GRANT AND D. F. HIGGINS

Much of the southern coast of the Kenai Peninsula, from Cape Puget at the western entrance to Prince William Sound to Port Chatham near the southwestern extremity of the peninsula, has been seldom visited and its glaciers are little known except for their approximate locations on the small scale charts of this region and for brief descriptions.† (Fig. 1.) In the summer of 1909 the writers studied this region and made a reconnaissance map of the coast line. All of the glaciers which reach tide water, or approach close to it, were seen and photographs were taken of many of these ice streams. Some of the photographs are here reproduced; these and others are preserved in the collection of the United States Geological Survey.

The southern coast of the Kenai Peninsula is deeply indented by bays which have mountainous shores, and snow-covered peaks are frequently in view near the heads of these bays. From this mountain area, the backbone of the Kenai Peninsula, glaciers extend southward and southeastward towards the Pacific. Some of these ice streams, as the Bear, Northwestern and McCarty glaciers, are of large size and reach tide water. These glaciers and their surroundings form scenes of beauty and grandeur which deserve to be much better known than they are at present. Back from the shore line little exploration has been done and there are large areas which have not been visited even by prospectors. Ice fields of unknown but considerable extent exist within 5 to 20 miles of the coast line.

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* Published with the permission of the Director of the United States Geological Survey.
Earlier articles in this series appeared in the *Bulletin*, vol. 42, 1910, pp. 721–738, and vol. 43, 1911, pp. 321–338, 401–417.

† Davidson, George. The glaciers of Alaska that are shown on Russian charts or mentioned in older narratives. *Trans. and Proc.* Geog. Soc. of the Pacific, series 2, vol. 3, 1904, pp. 1–98.

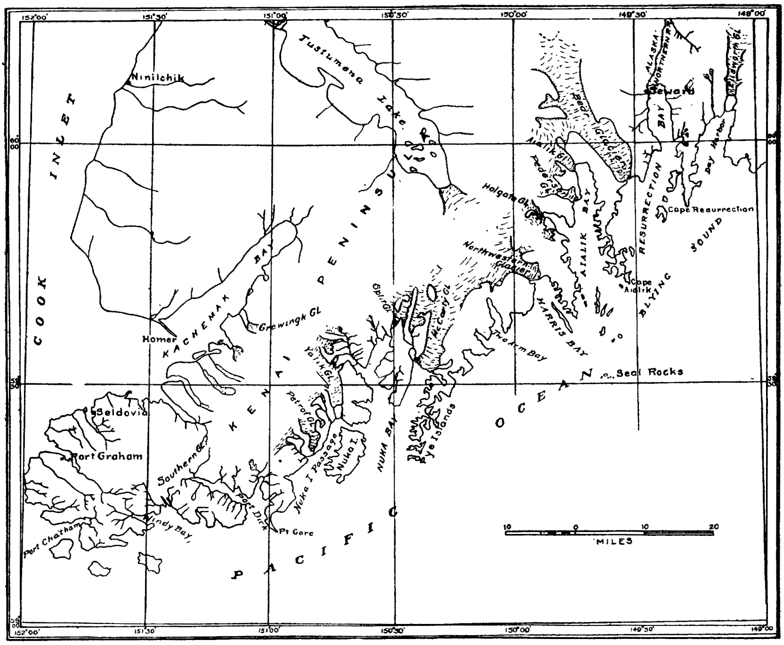

FIG. 1—Map of the southern part of the Kenai Peninsula, showing the coastal glaciers.

One of the most extensive of these,—possibly consisting of two or more separate parts,—occupies the elevated district included between Tustumena Lake and Resurrection, Aialik and Nuka bays. Another large ice field exists between Nuka Bay and Kachemak Bay of Cook Inlet and sends glaciers downward both to the southeast and the northwest.

CAPE PUGET TO CAPE RESURRECTION

Between Prince William Sound and Resurrection Bay, or more strictly between Capes Puget and Resurrection, there are at least four marked indentations of the shore line and valleys opening into these bays. Each of these valleys contains a glacier which from east to west are the Puget, the Excelsior, an unnamed glacier, and the Ellsworth. This coast lacks good harbors which are not exposed to the southerly winds and has consequently been little visited, except for Day Harbor, and not carefully mapped.

PUGET GLACIER

The Puget Glacier, a name we apply to it from the adjacent cape and bay, ends about a mile and a quarter from the head of Puget Bay. (Fig. 2.) This glacier is shown on Tebenkof's map* (1852) and probably also on Vancouver's map, though it is omitted from recent U. S. Coast and Geodetic Survey charts (Nos. 8502 and 8550).

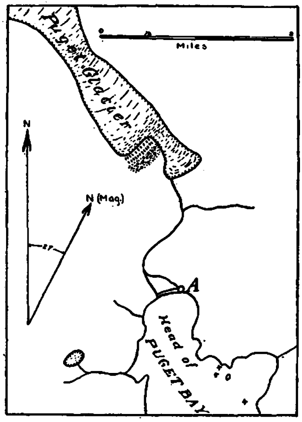

Fig. 2—Map of Puget Glacier, sketched from the head of Puget Bay, July 11, 1909.

The surface of the upper part of the Puget Glacier is smooth, but about a mile and a half from its end the glacier narrows and for half a mile its surface is steep and much crevassed. It then widens and becomes smooth again, but near its end passes over a cliff, and

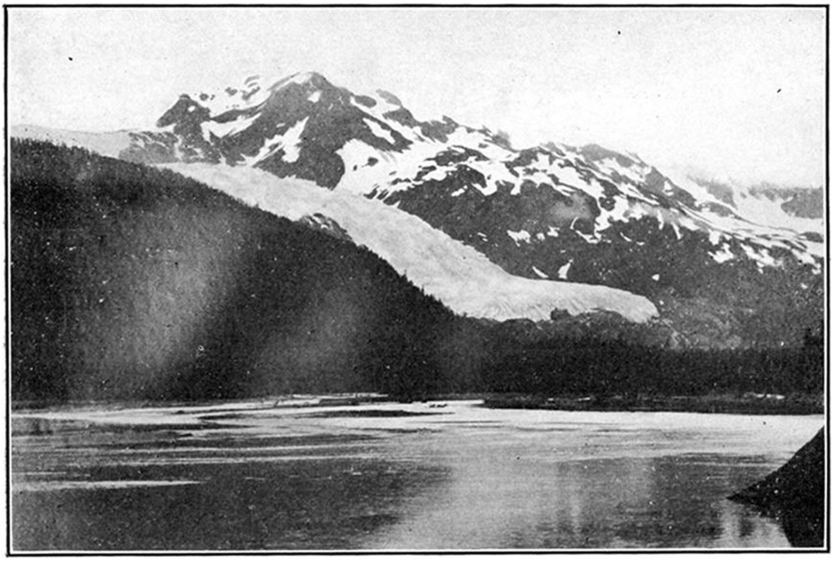

Fig. 3—Puget Glacier from Point A of Fig. 2, July 11, 1909.

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* Davidson, George, *op. cit.*, p. 20, map 5.

the western side of the glacier ends on the top of this cliff in an ice wall estimated to be 200 feet in height. From this wall blocks of ice fall over the cliff and probably do not consolidate again, although this fact was not conclusively shown from our point of view. The eastern part of the ice stream comes over this cliff in a much crevassed condition and then becomes smoother and deploys towards its end. (Fig. 3.) Beyond the end of the glacier is a considerable bare zone, between which and the sea is a mature forest. The bare zone appears to have been recently occupied by the glacier.

EXCELSIOR GLACIER

The Excelsior Glacier is shown on the earlier maps.* We passed within two miles of the glacier on July 11, 1909. Its front appears to be within half a mile of the sea. On the east is a very large bare zone between the ice and the forest, and on the west there is also a bare zone, but this is not so clearly seen. The glacier ends on a low gravel flat, the central part of which is bare of vegetation. From the appearance of these bare zones it seems that the Excelsior Glacier was considerably larger within a few years and its front may then have reached the sea.

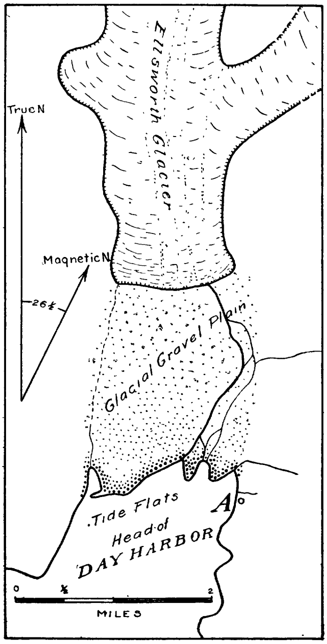

FIG. 4—Map of Ellsworth Glacier, sketched from the head of Day Harbor, July 12, 1909.

ELLSWORTH GLACIER

The Ellsworth Glacier is situated at the head of Day Harbor, the first bay east of Resurrection Bay. This glacier is not mentioned by Davidson† and evidently did not appear on the maps of Tebenkof and Vancouver. It is shown as reaching tide water on U. S. Coast and Geodetic Chart No. 8502 (1907).

The Ellsworth Glacier (Figs. 4 and 5) is an ice stream of considerable length and low slope. It ends about a mile and three-quarters from tide water. The eastern part of the front is much covered with débris, and the glacier carries four well-marked medial moraines. There are two feeders coming in from the east. About opposite the upper feeder there is a nunatak which does not rise much above the surface of the ice, and a little south of this feeder and farther west than the other is another nunatak of small size which rises very little above the ice surface. On the west side of the front of the glacier is a bare zone perhaps 200 feet in height, and on the east side of the front is a morainic deposit also bare of vegetation. There are also some morainic hillocks in front of the glacier, and part of the outwash plain is covered by vegetation. We did not visit the front of the glacier and so have no information as to recent retreat or advance except for the bare zone noted above. It is very improbable that this glacier has reached tide water within a century.

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* Davidson, George, *op. cit.*, p. 20, map 5.

† Davidson, George, *op. cit.*

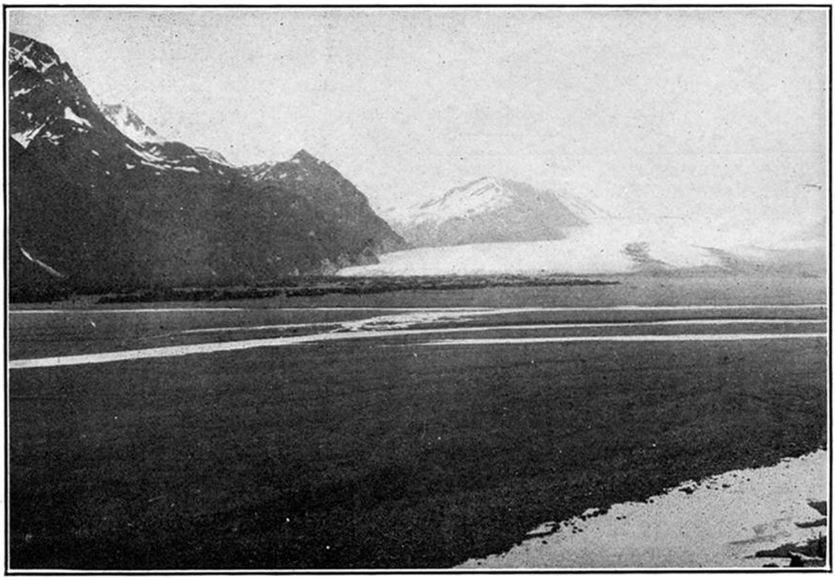

FIG. 5—Ellsworth Glacier from Point A of Fig. 4, July 12, 1909.

RESURRECTION BAY

Resurrection Bay is the most northerly extending indentation of the coast line of the Gulf of Alaska between Prince William Sound and Cook Inlet. At the head of this bay is the town of Seward, the terminus of the Alaska Northern Railroad and an outfitting point for the gold districts to the north. Seward has a most excellent location on an alluvial fan formed by a stream which comes from the mountains to the west. To the east of the town is the Godwin Glacier, which does not reach sea level; and farther south, on the narrow neck of land which separates Resurrection Bay from Day Harbor, are a few small glaciers. The most attractive of these are near the head of Thumb Cove, the largest of the small bays on the east side of Resurrection Bay. These glaciers are shown in the accompanying illustrations (Figs. 6 and 7) and they with the rugged mountain peaks about them form a most picturesque and beautiful scene.

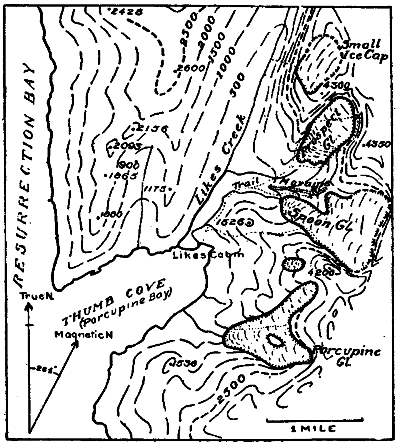

Fig. 6—Sketch map of glaciers east of Thumb Cove, Resurrection Bay, August 21, 1908. Shore line and elevations from U. S. Coast and Geodetic Survey; contour interval 500 feet.

BEAR GLACIER

On the west side of Resurrection Bay, thirteen miles from Seward, is the Bear Glacier, which is the largest ice stream to reach the sea on the Kenai Peninsula. (Figs. 8 and 9.) This glacier is shown on Chart No. 8538 of the United States Coast and Geodetic Survey, and the position of the glacial front in 1909 was essentially the same as when that chart was made (1905). The Bear Glacier has a comparatively low slope and carries two large medial moraines. The gravel flat on which the glacier rests is covered in part by the highest tides, and apparently a combination of highest tide and

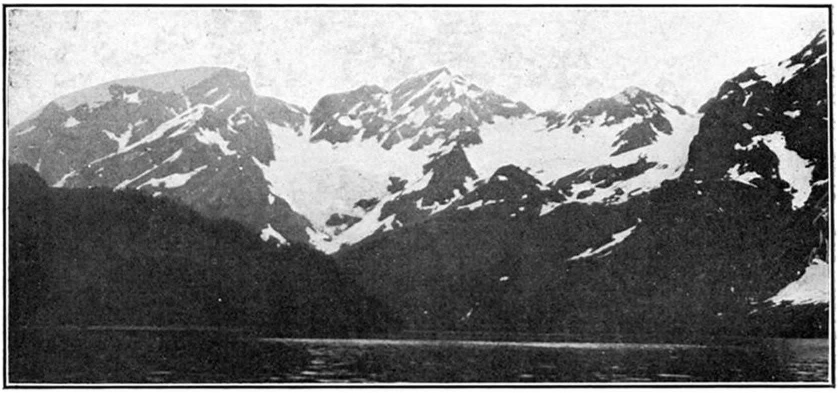

Fig. 7—Glaciers east of Thumb Cove, Resurrection Bay, August 21, 1908. At the left is the small ice cap shown in Fig. 6, and to the right of this ice cap are the Prospect, Spoon and Porcupine glaciers. The three peaks in the central half of the photograph are (from left to right) 4,300, 4,350 and 4,200 feet respectively above sea level.

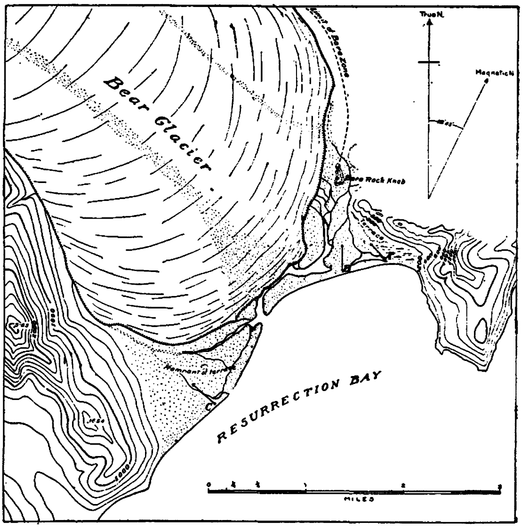

FIG. 8—Map of front of Bear Glacier, July 20 and 21, 1909. Occupied points indicated by circles; arrows show directions in which photographs were taken; contour interval 200 feet.

strong southerly wind brings waves over most of this flat. Along the center of the ice front ordinary high tide reaches the glacier. On the east side of the flat is a gravel terrace covered with grass and a few bushes; the terrace at its south end is at high tide level and ascends about 30 feet in going northward a mile. A small remnant of apparently the same terrace occurs on the western part of the glacial flat. The terrace probably represents the aggraded surface of the outwash plain when the glacial front stood farther back than at present. On the northeast of the glacial front is a bare rock face about 200 feet high, evidently recently glaciated. South of this is a rocky island in the glacial flat. The northwestern side of the island is bare of timber, and its southeastern side has

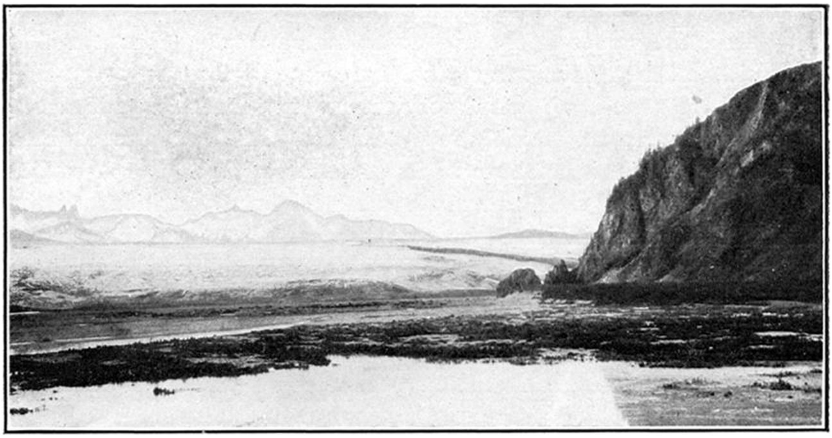

FIG. 9—East side of front of the Bear Glacier, from Point A of Fig. 8, July 20, 1909. The terrace is shown at the foot of the hill on the right.

timber. On the west side of the glacier front is a bare zone about 200 feet high and extending a quarter of a mile beyond the ice front. The glacier front thus has been somewhat (perhaps a quarter of a mile) in advance of its present position in comparatively recent years, but has not been farther advanced than the above since the growth of the present forest.

AIALIK BAY

Aialik Bay lies just west of Resurrection Bay. Parts of both sides of the former bay are very irregular, being indented by many approximately semi-circular coves. These represent old glacial cirques which have been drowned in the sea. Towards the upper part of the bay the cirques lie above sea level and near the head of the bay some of these cirques are now occupied by small glaciers. These drowned cirques are also found to the east on Resurrection Bay and to the southwest on Harris Bay and the Pye Islands. (See Fig. 14.)

Aialik Glacier

The Aialik Glacier reaches tide water at the west side of the extreme head of Aialik Bay (Fig. 10), whence the name of the glacier. The glacial front is a cliff estimated to be 200 feet in height, and from this cliff ice is being discharged rapidly. There is no medial moraine on the Aialik Glacier, and the lateral moraines, especially the one on the northeast side, are not large. At the center of the front a small mass of rock has just been uncovered by the ice, and there is another small mass just appearing about a third of the way from the center to the north side of the front (Fig. 11). On both sides of the glacier is a marked bare zone, and on the south side in this bare zone is a lateral moraine. When the ice extended out over this bare zone, possibly ten years ago, the front was about a quarter of a mile in advance of its present position. Much earlier (several centuries old) and much more advanced positions of the Aialik Glacier are indicated by shoals, caused by morainic accumulations, across the head of Aialik Bay, opposite and a mile north of the front of the Pedersen Glacier.

Pedersen Glacier

The Pedersen Glacier ends on a gravel flat four miles south of the Aialik Glacier. Toward its end the Pedersen Glacier is smooth, deploys upon a glacial flat, and is reached by high tide along its center (Fig. 10). On the northern side of the front there is a per-

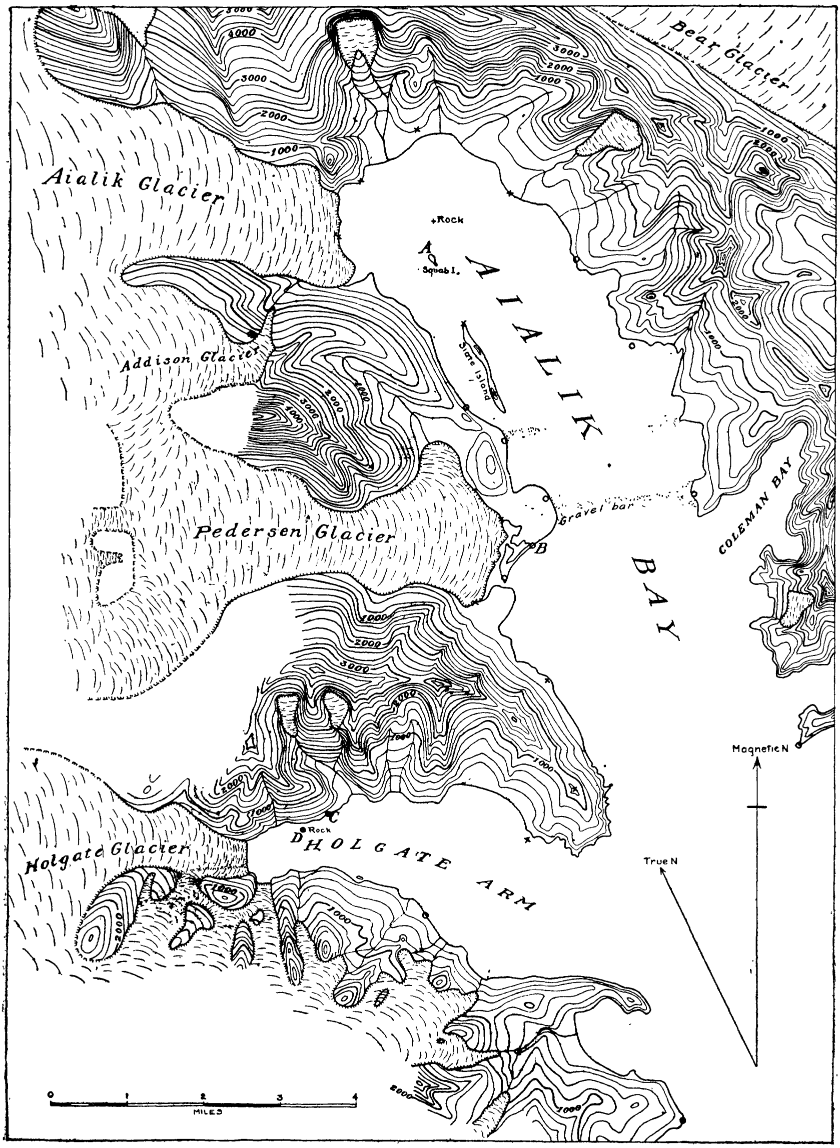

FIG. 10—Map of the upper part of Aialik Bay, July 22–24, 1909. Occupied points are indicated by circles, intersected points by crosses; contour interval 200 feet.

pendicular cliff of ice perhaps 100 feet in height. This glacier also has no medial moraine and has a well-marked bare zone on each side of the front. On the north side this zone is approximately 200 feet in height where it touches the ice, and it extends a third of a mile east from the present front of the glacier (Fig. 12). Along much of the front a quarter to a third of a mile from the ice are the remains of a low moraine which has now been nearly cut away by the waves. On this moraine are herbaceous plants and some alders about two feet in height. The moraine was probably deposited at the time when the glacier advanced to the edge of the bare zone mentioned above. This advance may have been fifteen years ago and apparently marks the maximum advance of the glacier since the advent of the present forest.

Holgate Glacier

The Holgate Glacier lies at the head of the main westerly branch of Aialik Bay and reaches tide water in two streams separated by a small mass of rock which not many years ago was a nunatak in this glacier. (Fig. 13.) The western and larger stream is discharging rapidly, but the discharge from the southern stream is small. Near the south side of the larger stream is a small medial moraine, but the glacier as a whole is free from medial moraines. The same statement can be made concerning the other glaciers on the west side of Aialik Bay. They all come from an extensive snow field which has few bare peaks rising above its surface. About three-fourths of a mile east of the front of the northern stream of the Holgate Glacier is a rounded reef (Point D, shown in Fig. 10) recently glaciated and now covered by the highest tides. There are no trees on the sides of Holgate Bay within 1.25 miles of its head, and beyond this the forest is sparse. There are no bushes and very few herbaceous plants close to sea level from the glacier to a quarter of a mile east of the reef mentioned above. The rock mass between the two parts of the glacial front has bushes only on its upper half on the front and upper fourth on the sides (Fig. 13). In very recent years then, possibly within the twentieth century, the front of the Holgate Glacier was about a mile in advance of its present (1909) position.

NORTHWESTERN GLACIER

This magnificent glacier (Figs. 14, 15 and 16) reaches the ocean at the head of Harris Bay, the second large bay southwest of Resurrection Bay. The Northwestern is one of the largest ice streams of the Kenai Peninsula and is in full view from the open ocean. This glacier and its surrounding lofty peaks form the most striking scenic feature of the southern shore of the Kenai Peninsula. The Northwestern Glacier, which we named after Northwestern Uni-

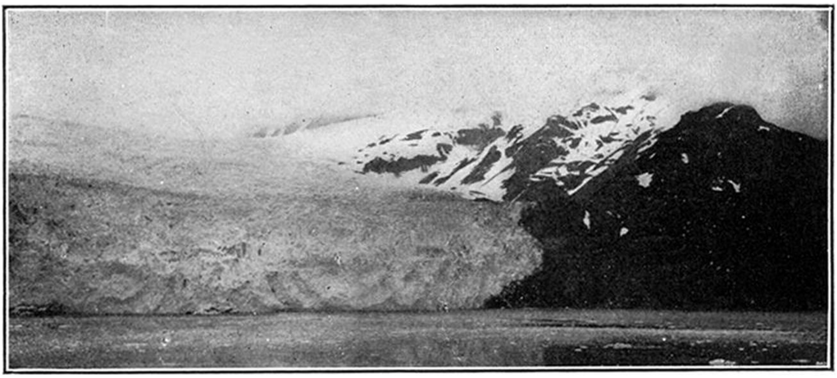

FIG. 11—North side of front of the Aialik Glacier, from Point A of Fig. 10, July 23, 1909. At the extreme left is a mass of rock recently uncovered by the ice; this rock is in about the center of the glacial front.

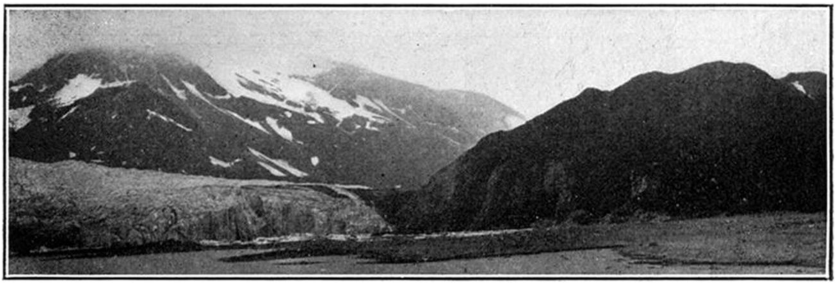

FIG. 12—North side of front of the Pedersen Glacier, from Point B of Fig. 10, July 23, 1909.

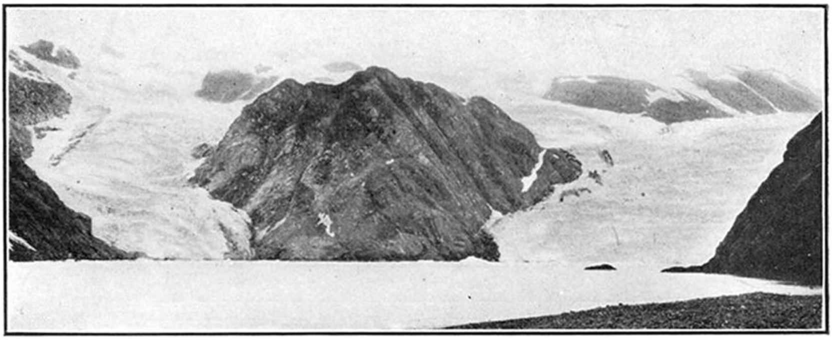

FIG. 13—Front of the Holgate Glacier, from Point C of Fig. 10, July 24, 1909. The small reef in front of the right part of the glacier is Point D of Fig. 10; this reef is now three-fourths of a mile from the ice front, but was covered by the ice possibly within the twentieth century.

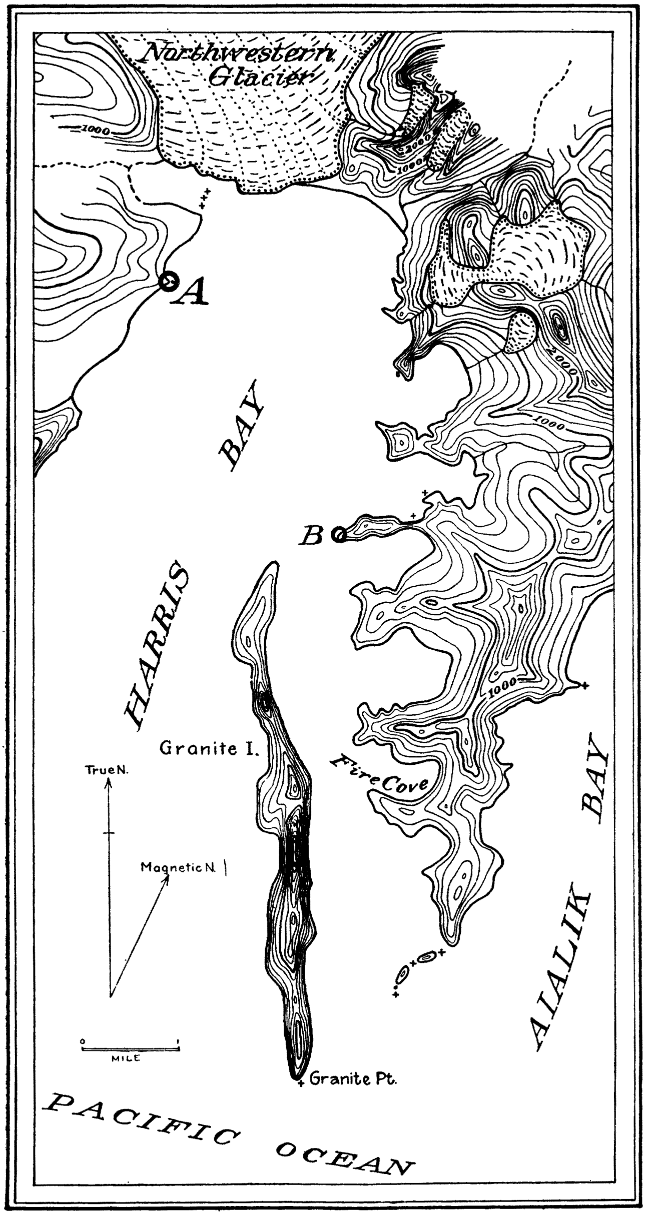

FIG. 14—Sketch map of Harris Bay and Northwestern Glacier, July 27, 1909. Contour interval 200 feet. Fire Cove and the adjacent similar coves are drowned cirques.

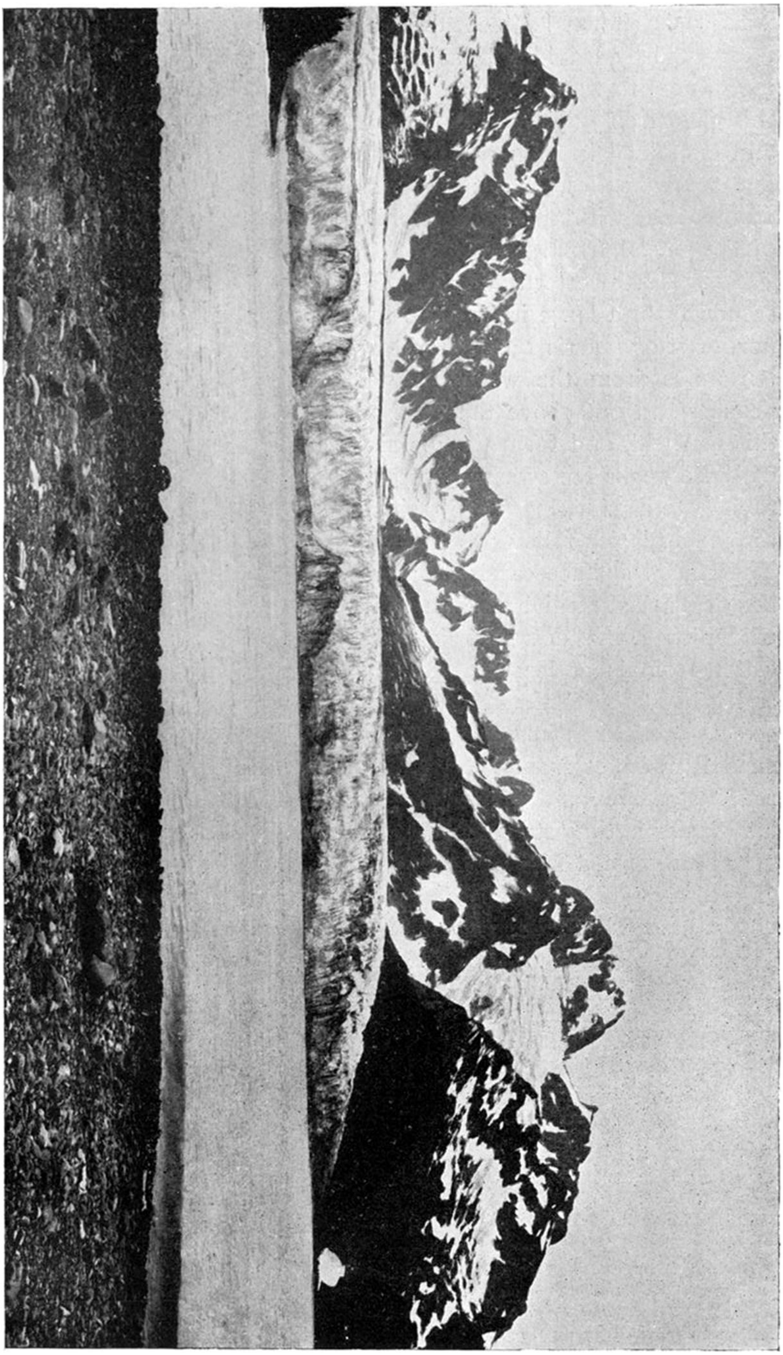

FIG. 15—Eastern part of front of Northwestern Glacier, from Point A of Fig. 14, July 27, 1909. The high peak on the left is the same peak as is shown on the right of Fig. 16.

versity, is shown by Tebenkof, as mentioned by Davidson,* as reaching almost to the sea. We visited this glacier on July 26 and 27, 1909, and examined it from points from one to five miles distant and also from a boat within less than a mile of the glacial front.

The Northwestern Glacier descends from a large ice field to the northeast of Harris Bay. Eight or ten miles from the water several peaks stand out above the edge of this ice field, and from the vicinity of these peaks ice streams descend rapidly to a wide, low valley which the main glacier follows to the sea. The glacial surface carries a number of marked medial moraines, six of which come down to its tide water frontal; at least two others end in the hills to the north. The peaks just mentioned and the medial moraines from them are of reddish granite, and the surface of the glacier is thus striped by bands of a buff color. The west quarter of the front of the glacier forms a steep cliff and is discharging rapidly. The eastern half of the front lies on a gravel flat, the eastern portion of which is not covered by high tide. On both sides of the front there is a bare zone between the glacier and the forest. This zone extends a quarter of a mile beyond the front of the glacier and is estimated to reach 150 feet in height above the

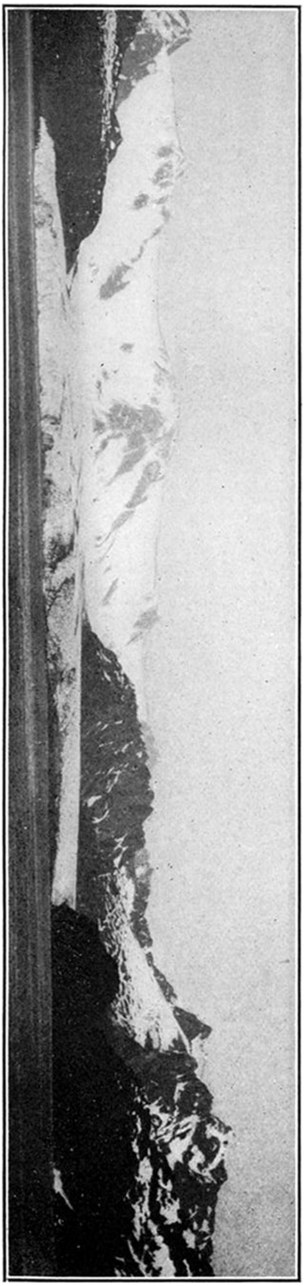

FIG. 16—General view of Northwestern Glacier, from Point B of Fig. 14, July 27, 1909.

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* Davidson, George. The glaciers of Alaska that are shown on Russian charts or mentioned in older narratives. *Trans. and Proc.* Geog. Soc. of the Pacific, series 2, vol. 3, 1904, pp. 1–98.

glacier near the front. The front of the Northwestern Glacier is now (1909) about a quarter of a mile from its maximum advance since the growth of the present forest. This maximum position was occupied perhaps 10 to 15 years ago.

NUKA BAY

Nuka Bay is the large inlet lying just west and northwest of the Pye Islands. It has several arms or branches. At the head of the eastern arm is the McCarty Glacier, the most westerly to reach tidewater on the southern shore of the Kenai Peninsula. The Split Glacier ends about two miles from the head of the northern arm. On the southwest shore of the northwest arm are at least four glaciers, but none of them ends near sea level. The western arm (Yalik Bay) has no glaciers draining into it. On the western side of Nuka Bay south of Yalik Bay are two larger glaciers (Yalik and Petrof) and several smaller ones which do not reach the sea but whose waters drain into Nuka Island passage.

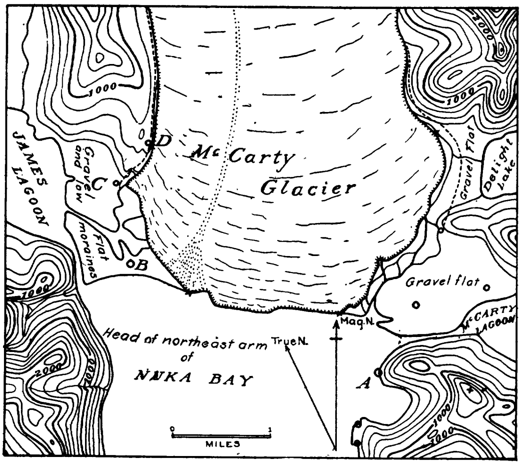

FIG. 17—Map of front of McCarty Glacier, July 30, 1909. Occupied points are indicated by circles, intersected points by crosses; dotted lines at side of glacier indicate limits of bare zone; contour interval 200 feet.

MCCARTY GLACIER

The McCarty Glacier reaches the sea at the head of the northeastern arm of Nuka Bay (Figs. 17 and 18). This glacier has a prominent medial moraine in its western half, and this moraine stands up above the ice surface as a ridge. The front of the glacier deploys in semi-circular form on a gravel flat which is mainly above sea level. At the center of its front, however, the glacier reaches tide water and in places presents a steep mural escarpment about 200 feet in height. From this wall ice blocks fall into the water, which is so shallow that the larger bergs do not float away.

On the east of the front of the McCarty Glacier is a broad pitted plain and nearer the ice are morainic ridges which mark an advance of the ice some years ago. Between the glacier and Delight Lake these morainic ridges reach a height of sixty feet. South of this lake a rock ridge extends westward to within about a quarter of a mile of the glacier. The end of the ridge is of bare rock and has been glaciated up to a height of 250 feet, at which elevation the ice invaded a mature forest and killed many of the trees which are now without bark and are mostly lying on the ground. Among them are live spruces, the largest of which are twelve feet high and six inches in diameter. The advance of the ice which destroyed these larger trees and constructed the morainic ridges just mentioned occurred perhaps fifty years ago and is the extreme advance of the eastern part of the glacier since the growth of the present forest.

The extreme western side of the McCarty Glacier falls abruptly over the point of a rock ridge some 350 feet in height. From the top of this ridge and just west of the ice (Point D of Fig. 17) an excellent view of the glacier and its environs is obtained. Here are two lateral moraines now beyond the edge of the ice. The older and outer of these moraines is not very well defined and varies from a few feet to twelve feet in height. Moss and young spruce trees cover most of the surface of this moraine, and in it are numerous bits of wood and fragments of logs and stumps. Just outside of this moraine (*i. e.*, to the west) is a forest, practically all of whose trees near the ice were killed at apparently the same time that the

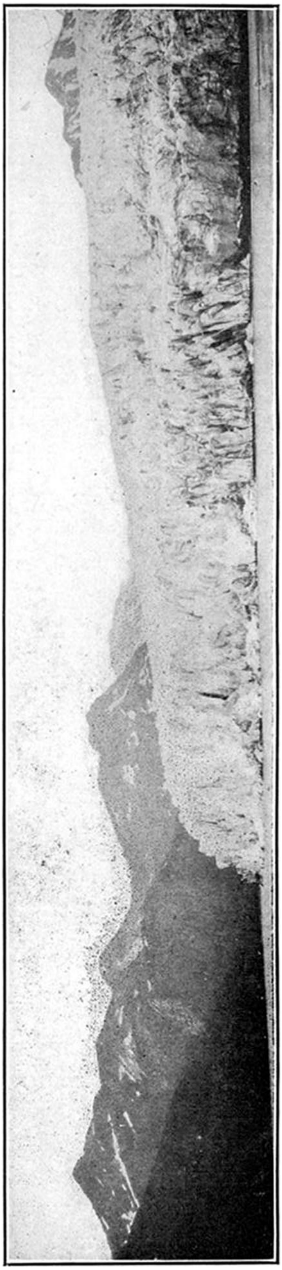

FIG. 18—Central part of front of McCarty Glacier, from Point A of Fig. 17, July 30, 1909.

moraine was formed. These trees are in about the same state of decay as the fragments of trees in the moraine, and they are all in a more advanced stage of decomposition than the trees at any other locality described in this report where forests have been invaded by the ice, excepting the forest destroyed by the maximum advance of the eastern part of the Columbia Glacier. This maximum extent of the western part of the McCarty Glacier probably occurred at the same time as the maximum advance shown on the eastern side of the same glacier.

To the east of the above lateral moraine is another similar, but much younger, moraine. On this there is little moss, but many young spruce trees one to twelve inches high.

THE REAL NEW YORK IN 1910

BY

MARK JEFFERSON

According to the Thirteenth Census, the "city" at the mouth of the Hudson now contains 4,736,000 inhabitants, and 369,000 suburbanites dwell under the same city government with them, the distinction being made that city dwellers inhabit continuous areas every part of which has 10,000 or more people to the square mile. (*Bulletin*, Sept. 1909, p. 544.) All live within the charter limits of New York, Jersey City and Hoboken, making one great group of population about the port.*

Here men dwell closer together than anywhere else in the world, as far as statistics reach. At the time of the Twelfth Census, Ward 10 in Manhattan was thronged with people at the rate of 418,000 to the square mile. That is between the Bowery and Norfolk, Rivington and Division Streets. In the recent decade this has diminished to 386,000, but the density in Ward 11, which lies just east of Tompkins Square, had risen above 446,000. Furthermore, the new enumeration in city blocks shows a third of the blocks in Ward 11 to have more than 500,000 inhabitants to the mile. In fact, it appears probable by studies being made on these data that the five blocks east of Broadway between Delancey and Broome Streets have each more than 600,000 to the mile density.

The map denotes this eastward shifting of the densest population by the black shade of Ward 11. The withdrawing of the popu-

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* If Newark were included in the group, the numbers would become 5,044,444 and 409,000.